Science and the State.

IN reference to the recent memorandum signed by thirty-six eminent men of science on the neglect of science in our national organisation, it may be of some interest to your readers to be reminded of the paragraph on a similar topic written by Thomson in his "History of Chemistry," which appeared in 1831, or more than three-quarters of a century ago:—

"What Minister in Great Britain ever attempted to cherish the sciences, or to reward those who cultivate them with success? If we except Mr. Montague, who procured the place of master of the Mint for Sir Isaac Newton, I know of no one. While in every other nation in Europe science is directly promoted, and considerable sums are appropriated for its cultivation and for the support of a certain number of individuals who have shown themselves capable of extending its boundaries, not a single farthing has been devoted to any such purpose in Great Britain. Science has been left entirely to itself; and whatever has been done by way of promoting it has been performed by the unaided exertions of private individuals."

The above statement is not literally true of the present day; but the same spirit of indifference still exists.

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Altitudes of Auroræ.

IN NATURE of August 7, 1913 (vol. xci., p. 584), a short account was given of my auroral expedition of 1913. I think, therefore, that the accompanying preliminary result of the determination of altitude (Fig. 1) will interest your readers. More details will soon be published in the *Comptes rendus* of the Paris Academy of Sciences, in the *Astrophysical Journal*, and especially in *Terrestrial Magnetism and Atmospheric Electricity*, where a series of reports are in the press.

Kristiania, February 15. CARL STÖRMER.

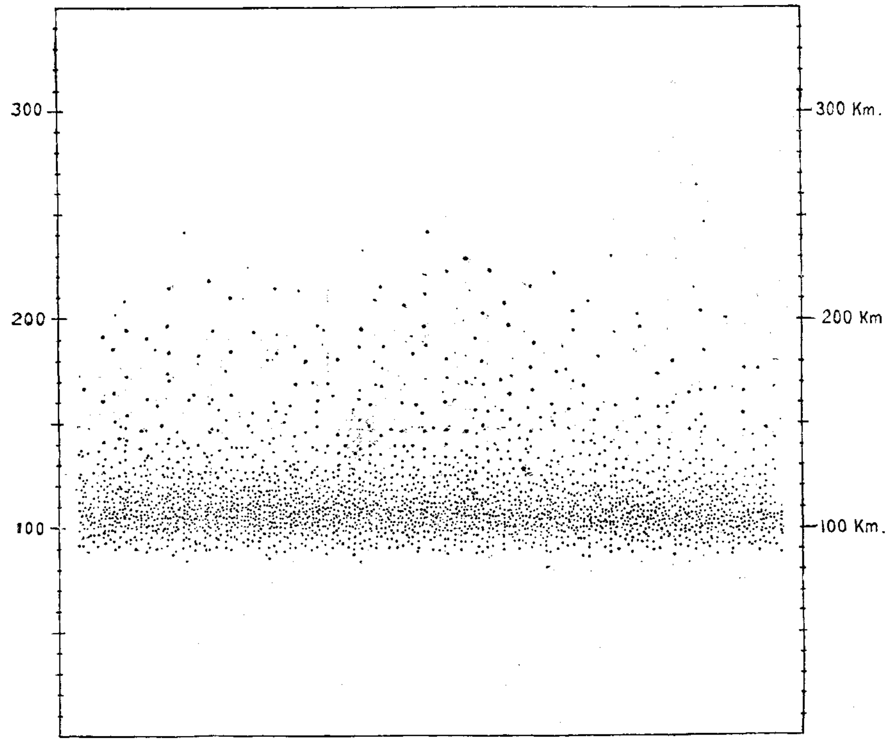

FIG. 1.—The altitude of aurora borealis seen from Bossekop during the spring of 1913. Each calculated altitude is marked by a dot and the several hundred simultaneous photographs of aurora from the stations—Bossekop and Store Korsnes—(mutual distance 27½ kilometres) gave about 2500 determinations of height, which are seen above.

Ground Rainbows.

MY observations of ground rainbows are here described in the hope of learning whether the phenomenon is well known. I can find no reference to it, and no information as to how the gossamer, which causes the rainbow, and seems to be a kind of spider-web, comes to be spread over so large an area.

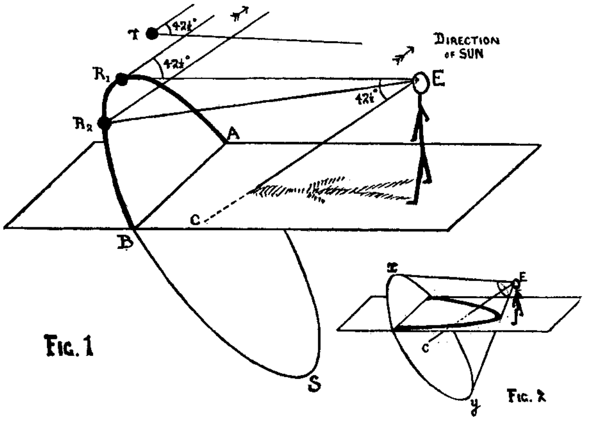

FIG. 1

FIG. 2

The ground rainbow observed occurred about 11.0 a.m. on October 14, 1915. A cricket field of about two acres was covered with a thick layer of gossamer which the early morning mist had loaded with millions of glittering beads of water. As one walked over the ground a rainbow of about the brilliancy of a good secondary bow moved over the grass—stretching from one's feet in the direction away from the sun in a sweeping curve with two arms. The explanation is obvious on the ordinary theory of primary rainbows.

Those rays will enter the eye which fall on the drops in the direction of the thick circle, AR_1R_2BSA (Fig. 1). But the raindrops were all on the ground, and so what the eye saw was the underneath part, ASB, of the rainbow circle—that is, the rays which lie on the under surface of the cone, Exy (Fig. 2). The rainbow is therefore the trace of the cone, Exy, on the ground plane. It follows at once that the form of this trace will depend on the angle of elevation of the sun; when the sun is in the zenith the curve is a circle when the angle of elevation is between 90° and 42° it is an ellipse, when 42° a parabola, and when below 42° a hyperbola. Some of my pupils measured the elevation, by finding the height and length of

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shadow of an observer, and found it to be 23°. They also pegged out the curve and proved it a hyperbola, and showed that half the angle of the cone was approximately 42°. The gossamer was spread quite evenly over the field, and at the brightest part of the morning—which was still and cloudless—a slight secondary bow could be distinguished.

Mr. N. T. Porter has sent me some photographs of gossamer taken on the lawn of Downing College, Cambridge, one morning some weeks before; when a similar ground rainbow was seen. He adds that he has noticed the gossamer fall in thick clouds on several occasions when out shooting in the early morning.

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THE APPLICATION OF SCIENTIFIC METHODS TO THE IMPROVEMENT OF THE SUGAR BEET.

AN important memoir on the production of improved seeds of the sugar beet is published by M. E. Schribaux in the *Bulletin de la Société d'Encouragement.*[1] The memoir gives one of the best accounts that has yet appeared of the methods of selection which have proved so successful in improving the quality of the sugar beet during the past fifty years. It is to these improvements that the remarkable growth of the beet sugar industry is largely due. They provide an admirable illustration of what can be effected by applying rigorous scientific methods to agricultural practice and industry on the large scale, and demonstrate scientific control pushed to a limit which only a few years back would have been regarded as impracticable or even impossible. This can be best appreciated when it is stated that in selecting the best beet roots to be used as seed-producers, every single root which appears suitable on morphological or other grounds is subjected to chemical analysis. Often more than 3000 roots are analysed each day; for this purpose a staff of three men, assisted by ten women or children, is necessary, and the price of each analysis works out at about four centimes.

The accompanying diagram (Fig. 1) shows at a glance the improvement that has been effected in the quality of the beet since it was first grown as a raw material of the sugar industry. During the interval from 1838 to 1870 seed growers confined their attention almost entirely to physical characteristics, such as form; these efforts were not without success, and led to the adoption of the type which, after its selection by Rabethge and Giesecke, became known as the *Klein Wanzleben,* from the district in Saxony in which it was grown. During this period, too, it was noticed that the largest roots are always the poorest, and a medium-sized root only was therefore aimed at. From 1838 to 1870, the increase in the percentage of sugar was but small, namely, from 8·8 to 10·1 per cent.

The second period of selection opened with the discovery by Louis de Vilmorin of the fact that, although the saccharine quality of the beet is a hereditary character, in order to maintain the improvement of the stock it is necessary to repeat the selection of the seed-bearing plants (*porte-graines*) at frequent intervals. He created the celebrated race *Vilmorin améliorée* associated with his name, by adopting a strictly scientific control in place of the empirical one which had previously determined selection. To ascertain the richness in sugar of the mother plants Vilmorin at first floated the roots in baths of salt or sugar solutions of known specific gravity. This method was soon replaced by a process of ascertaining the density of the juice expressed from small sectors of the roots, and this, in turn, gave way to the polarimetric process which is now universally in use. The methods introduced by Vilmorin were adopted with great success between 1870 and 1890, especially in Germany; during this period of twenty years the sugar content was raised from 10·1 to 13·7 per cent.

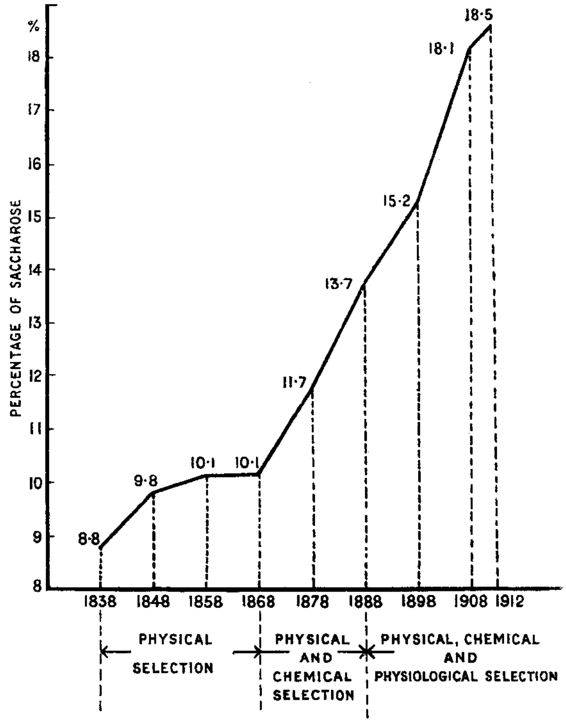

FIG. 1.—Variation of richness in sugar of industrial sugar beets.

Up to this date, however, attention was given only to direct heredity, selection being confined to the mother roots. The next great step in the improvement of the beet was introduced by taking into account the ancestral heredity of the seed-bearers, *pedigree* or *genealogical* selection being adopted. This method was defined by Vilmorin as follows: "It consists in valuing the different reproducing plants separately and individually, keeping the seeds produced by each apart, and determining by direct experiment the faculty of transmission which each plant enjoys." From 1898 to 1912, by this *individual* method of selection, aided and controlled by chemical ana-

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[1] "La production des graines de betterave industrielles assurée par l'agriculture française." By E. Schribaux. (*Bull. Soc. d'Encouragement.* vol. cxxiv., No. 4, pp. 178–251)

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